

**OPTICAL INK LEVEL DETECTING ARRANGEMENTS FOR INK CARTRIDGES****Background of the Invention**

It is of course known to provide ink cartridges for printers with arrangements for optically detecting the level of ink in a chamber or chambers of an ink cartridge. Generally, the optical system includes an optical ink detecting section, such as a prism, in an ink chamber of a cartridge and which is immersed in the ink when the latter is in the chamber above a certain level, and the ink level is read by a light emitting optical unit comprising a light emission device and a photo receptor outside the cartridge. The interface of the optical detecting section extends transverse to the plane of scanning as defined by the light path between the emitter and receptor. If, for example, the scanning takes place in a printer, and the cartridge moves transverse to the direction between the front and rear ends thereof, the plane of the light path between the emitter and receptor is likewise transverse to the direction between the front and rear ends of the cartridge, whereby the light enters the detecting section and reflects off the interface thereof to the receptor. The amount of light which is reflected to the receptor is indicative of the level of ink in the chamber. Such level detecting arrangements are shown, for example, in patents 5,616,929 to Hara and 6,361,136 to Watanabe, et al.

It will be appreciated of course that at least the portion of the cartridge in which the level detector is disposed of light transmitting material, and that the light used for determining the ink level can either be visible light or infrared. Ink level detectors such as prisms provided in ink cartridges for use in a single printhead printer are in a single plane of alignment with the plane of the light path of the light emitting optical unit. At the same time, a printer with multiple printheads can have black and color ink cartridges in different scanning or alignment planes. Accordingly, two different ink cartridge configurations are required for use in single and multiple printhead printers. Furthermore, optical prisms provided in cartridges heretofore available are formed integral with the bottom wall of the cartridge and, accordingly, limit the versatility with respect to the plastic materials which can be used for constructing the cartridges.

**Summary of the Invention**

In accordance with the present invention, improvements are provided with respect to optical prism arrangements for ink jet cartridges by which the foregoing and other disadvantages of cartridges heretofore available are minimized or overcome. More particularly in this respect, and in accordance with one aspect of the invention, multiple, independent prism segments are provided in an ink cartridge which allows one cartridge configuration to be used in single or multi-printhead

printers. The interface of each of the prisms is in a corresponding plane transverse to the direction between the front and rear ends of the cartridge, whereby the cartridge has the ability to detect ink levels in connection with a plurality of different scanning planes which are parallel and spaced apart in the direction between the front and rear ends of the cartridge. A further advantage with respect to multiple prism segments is realized in connection with the molding of the plastic materials of the cartridge. In this respect, the individual prisms are relatively thin with respect to the scanning plane and, according, are easier to mold without problems due to cooling a larger mass of plastic material which can result in defects in the prism surfaces which can cause the prism to be non-functional.

In accordance with another aspect of the invention, single or multiple prism components are separate from and assembled with a cartridge to provide an ink level detecting arrangement therefor. The prism or prisms can be mounted in a recess in a chamber wall of a cartridge together with an optical gel which will allow the interface of the prism to become optically transmissive. Alternatively, the prism unit can be assembled with the cartridge so as to be directly exposed to ink in the ink chamber. Preferably, the level detector is removably interengaged with the cartridge, such as through a snap fit. However, the detector could be separate from and permanently attached to a cartridge, such as by heat welding. A primary advantage of the two piece prism-cartridge arrangement is to enable the use of unlike types of plastic materials for the cartridge and detector components.

It is accordingly, an outstanding object of the present invention to provide improvements in connection with optical ink level detecting arrangements in ink cartridges.

Another object is the provision of an ink cartridge with an ink level detecting arrangement which enables the cartridge to be used in single or multi-printhead configuration printers.

Another object is the provision of an optical ink level detecting arrangement for an ink cartridge in which an optical prism or prisms and the cartridge can be of different plastic materials.

Another object is the provision of an ink level detecting arrangement for an ink cartridge in which an optical prism element is separate from and assembled with an ink cartridge.

### **Brief Description of the Drawings**

The foregoing objects, and others, will in part be obvious and in part pointed out more fully hereinafter in conjunction with the written description of preferred embodiments of the invention illustrated in the accompanying drawings in which:

FIGURE 1 is a sectional elevation view of an ink cartridge having a multi-segmented ink level detecting prism in accordance with the present invention;

FIGURE 2 is an enlarged plan view of the prism segments looking in the direction of line 2-2 in Figure 1;

FIGURE 3 is an enlarged cross-sectional elevation view of the prism segments along line 3-3 in Figure 1;

FIGURE 4 is an enlarged sectional elevation view of the bottom wall of an ink cartridge having a cavity and an optical prism assembled therewith in accordance with another embodiment of the invention;

FIGURE 5 is a cross-sectional elevation view of the prism looking in the direction of line 5-5 in Figure 4; and,

FIGURE 6 is a cross-sectional elevation view through a prism component mounted on a bottom wall of an ink cartridge in accordance with yet another embodiment of the invention.

### **Description of Preferred Embodiments**

Referring now in greater detail to the drawings, wherein the showings are for the purpose of illustrating preferred embodiments of the invention only and not for the purpose of limiting the invention, Figures 1-3 illustrate an ink cartridge 10 having ink chambers 12 and 14 and a bottom wall 16 having an ink outlet 18 from chamber 14 and an optical prism unit 20 in chamber 12. While not shown, chamber 14 is generally provided with a block of porous ink absorbing material, and chamber 12 generally receives free ink which is progressively fed to the ink absorbing material in chamber 14 through a window or opening 22 in a partition wall 24 which divides the interior of the cartridge into the two chambers. The cartridge further includes side walls 26 and 28 and front and rear walls 30 and 32, respectively.

In accordance with this embodiment, at least the portion of bottom wall 16 supporting the optical prism is of light transmitting material, and optical prism unit 20 comprises three individual prisms 34, 36 and 38 each of which, as will be appreciated from Figures 2 and 3, includes a corresponding interface defined by angularly related surfaces 34a and 34b, 36a and 36b, and 38a. The surfaces of each pair of surfaces are preferably at an angle of 90° to one another. When the cartridge is mounted in a printer carriage, the cartridge moves therewith along a path in a direction transverse to the direction between the front and rear ends of the cartridge and which direction is

indicated in Figure 2 of the drawings by arrows P1, P2 and P3 which laterally bisect prisms 34, 36 and 38, respectively. Arrows P1, P2 and P3 also represent potential alignment planes between the corresponding prism and a light emitting optical unit by which an ink level can be detected and indicated via the optical unit. The prisms 34, 36 and 38 can be produced in connection with the molding process for the bottom wall of the cartridge or, alternatively, can be provided by cutting a unitary molded prism component into three segments. Further, as will become apparent hereinafter, the three segment prism unit can be produced separate from the cartridge and assembled therewith.

Referring now to Figures 4 and 5 of the drawing, the bottom wall 40 of a cartridge is provided with a downwardly open recess 42 which, in the direction between the front and rear ends of the cartridge, is provided with front and rear walls 44 and 46, respectively, side walls 48 and a bottom or inner wall 50. The lower ends of the inner sides of walls 44, 46 and 48 are provided with corresponding undercut portions 44a, 46a and 48a which provide for a prism component 52 having corresponding undercut portions 52a to be received in recess 42 and interengaged therewith by a snap-fit therebetween. As will be appreciated from the embodiment shown in Figures 2 and 3, prism component 52 has angularly related surfaces 54 and 56 which are bisected by an alignment plane parallel to the plane of Figure 5. The cartridge, and thus the prism, moves along the alignment plane as indicated by arrows P4, for the prism to traverse the light emitting and receptor component of a light emitting optical unit operable to detect the level of ink in the cartridge. Preferably, the areas between prism surfaces 54 and 56 and the corresponding portions of recess walls 48 and 50 are filled with an optical gel 58 which optimizes the optically transmissive characteristic of prism surfaces 54 and 56.

Referring now to FIGURE 6 of the drawing, the bottom wall 60 of an ink cartridge is provided with an opening 62 between the inner and outer surfaces 60a and 60b, respectively, of the bottom wall. Opening 62 is adapted to provide for the mounting of a prism component 64 on the bottom wall of the cartridge and, in the embodiment shown, such mounting is achieved by providing for opening 62 to have a shallow V-shaped configuration about the periphery thereof as defined by upper and lower surfaces 62a and 62b, respectively, and by providing for prism component 64 to have corresponding V-shaped upper and lower surfaces 64a and 64b, respectively, which provide for a snap-fit between the opening and prism. As will be appreciated from the description herein of the preceding embodiments, prism component 64 has angularly related surfaces 66 and 68 bisected

by an alignment plane with respect to the path of light to one of the surfaces from a light emitting device of an optical unit and reflection of the light to the other surface and thence to a photo receptor of the optical unit.

As will be appreciated from the embodiments herein illustrated and described, a multiple  
5 segment prism component can be produced separate from an ink cartridge and assembled therewith or mounted thereon as shown in the embodiments of Figures 4-6 and that, with respect to such an assembly or those shown in Figures 4-6, the prism component can be permanently assembled with the cartridge such as by an adhesive bond or heat seal.

While considerable emphasis has been placed herein on the structures and structural  
10 interrelationships between the component parts of preferred embodiments, it will be appreciated that other embodiments can be devised and that many changes can be made in the preferred embodiments without departing from the principals of the present invention. In this respect, for example, the light detecting elements can be of a configuration other than triangular, and can be on a wall of a cartridge other than the bottom wall. Accordingly, it is to be distinctly understood that the foregoing  
15 descriptive matter is to be interpreted merely as illustrative of the present invention and not as a limitation. Further, it is intended to include all such modifications and alternate embodiments in the appended claims insofar as they are within the scope of the claims or equivalents thereof.